

width MW1 of the signal metal patterns 230 may be different from the width of the cell metal patterns 220.

[0087] The dummy metal patterns 240 may be formed in portions of the peripheral region PR of the semiconductor substrate 210 in which the signal metal mask patterns 230 are not arranged. Because a shape of the dummy metal patterns 240 may be determined in accordance with the shape of the second mask patterns 140, the dummy metal patterns 240 may have an elongated bar shape. The dummy metal patterns 240 may be positioned adjacent to the signal metal patterns 230. The dummy metal patterns 240 may have the second width MW2 substantially the same as the first width MW1 of the signal metal pattern 230.

[0088] Referring to FIG. 11, the dummy metal pattern 240 may be positioned adjacent to a signal metal pattern 232 having a relatively short length. The signal metal pattern 232 and the dummy metal pattern 240 may be positioned on a straight line. Because the first width MW1 of the signal metal pattern 232 may be substantially the same as the second width MW2 of the dummy metal pattern 240, the signal metal pattern 232 and the dummy metal pattern 240 may have a same center line CL along the straight line. The dummy metal pattern 240 may be spaced apart from the signal metal pattern 232 by a gap MG. The gap MG may be a distance between adjacent surfaces of the signal metal pattern 232 and the dummy metal pattern 240.

[0089] Referring to FIG. 12, a dummy metal pattern 242 having a relatively short length may be arranged between two signal metal patterns 234 and 235, each having a relatively short length, positioned on a straight line. The dummy metal pattern 242 may be positioned on the straight line. Thus, the signal metal patterns 234 and 235 and the dummy metal pattern 242 may have the common center line CL, along the straight line.

[0090] Further, a gap between the dummy metal pattern 242 and the signal metal pattern 234 may be substantially the same as a gap between the dummy metal pattern 242 and the signal metal pattern 235. For example, a first gap MG1 between adjacent side surfaces of the dummy metal pattern 242 and the signal metal pattern 234 may be substantially the same as a second gap MG2 between adjacent side surfaces of the dummy metal pattern 242 and the signal metal pattern 235. The first gap MG1 and the second gap MG2 may be substantially the same as the gap MG between the signal metal pattern 232 and the dummy metal pattern 240 in FIG. 11. The gap MG the first gap MG1 and the second gap MG2 may be determined in accordance with a design rule of the metal wiring in the semiconductor device.

[0091] Referring to FIG. 13, the two signal metal patterns 230 in the peripheral region PR may be parallel to each other. The signal metal patterns 230 may have a first width MW1. In FIG. 13, the upper signal metal pattern 230 may have a first center line CL1. The lower signal metal pattern 230 may have a second center line CL2. A pitch between the signal metal patterns 230 in the peripheral region PR may be wider than the pitch between the cell metal patterns 220 in the cell region CR.

[0092] A dummy metal pattern 244 may be arranged between the signal metal patterns 230. The dummy metal pattern 244 may have a length substantially the same as the length of the signal metal patterns 230. The dummy metal pattern 244 may have the second width MW2 substantially the same as the first width MW1 of the signal metal patterns 230. The dummy metal pattern 244 may be substantially

parallel to the signal metal patterns 230. Thus, the dummy metal pattern 244 may have a third center line CL3 substantially parallel to the first and second center lines CL1 and CL2 of the signal metal patterns 230.

[0093] The signal metal patterns 230 and the dummy metal pattern 244 may be arranged by substantially the same pitch. For example, a first pitch MP1 between the dummy metal pattern 244 and the upper signal metal pattern 230 may be substantially the same as a second pitch MP2 between the dummy metal pattern 244 and the lower signal metal pattern 230. That is, a distance between an upper surface of the dummy metal pattern 244 and a lower surface of the upper signal metal pattern 230 may be substantially the same as a distance between a lower surface of the dummy metal pattern 244 and an upper surface of the lower signal metal pattern 230.

[0094] Referring to FIG. 14, the signal metal pattern 230 and a signal metal pattern 236 in the peripheral region PR may be parallel to each other. In FIG. 14, the upper signal metal pattern 230 may have the first width MW1, and the lower signal metal pattern 236 may have a third width MW3 wider than the first width MW1. The upper signal metal pattern 230 may have a first center line CL1. The lower signal metal pattern 236 may have a second center line CL2. A pitch between the signal metal patterns 230 and 236 in the peripheral region PR may be wider than the pitch between the cell metal patterns 220 in the cell region CR.

[0095] A dummy metal pattern 246 may be arranged between the signal metal patterns 230 and 236. The dummy metal pattern 246 may have a length substantially the same as that of the signal metal patterns 230 and 236. The dummy metal pattern 246 may have the second width MW2 substantially the same as the first width MW1 of the signal metal pattern 230. According to some example embodiments, the second width MW2 of the dummy metal pattern 246 may be substantially the same as the third width MW3 of the signal metal pattern 236. The dummy metal pattern 246 may be parallel to the signal metal patterns 230 and 236. Thus, the dummy metal pattern 246 may have a third center line CL3 substantially parallel to the first and second center lines CL1 and CL2 of the signal metal patterns 230 and 236.

[0096] The signal metal patterns 230 and 236 and the dummy metal pattern 246 may be arranged by substantially the same pitch. For example, a third pitch MP3 between the dummy metal pattern 246 and the upper signal metal pattern 230 may be substantially the same as a fourth pitch MP4 between the dummy metal pattern 246 and the lower signal metal pattern 236. That is, a distance between an upper surface of the dummy metal pattern 246 and a lower surface of the upper signal metal pattern 230 may be substantially the same as a distance between a lower surface of the dummy metal pattern 246 and an upper surface of the lower signal metal pattern 236.

[0097] Referring to FIG. 15, the two signal metal patterns 230 in the peripheral region PR may be parallel to each other. The signal metal patterns 230 may have the first width MW1. In FIG. 15, the upper signal metal pattern 230 may have the first center line CL1. The lower signal metal pattern 230 may have the second center line CL2. A pitch between the signal metal patterns 230 in the peripheral region PR may be wider than the pitch between the cell metal patterns 220 in the cell region CR. For example, the pitch between the signal metal patterns 230 in FIG. 15 may be wider than the pitch between the signal metal patterns 230 in FIG. 13.